Seeing is Believing: Experimental Evidence of the Impact of Eyeglasses on Academic Performance, Aspirations and Dropout among Junior High School Students in Rural China*

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Abstract: We present the results of a randomized trial testing the impact of providing free eyeglasses on academic outcomes of junior high school students in a poor rural area of western China. We find that providing free prescription eyeglasses approximately halves dropout rates over a school year among students who did not own eyeglasses at baseline. Effects on dropout are mirrored by improvements in student performance on standardized exams in math and aspirations for further schooling.

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I. Introduction

It is estimated that nearly 10% to 15% of children of school age in developing countries are visually impaired (Resnikoff et al. 2008; Pascolini and Mariotti 2012) . The vast majority of these cases are due to refractive error (e.g., myopia) that can be effectively addressed with properly-fitted eyeglasses, yet eyeglasses are taken up at low rates (Resnikoff et al. 2008; Pascolini and Mariotti 2012). Like other health conditions affecting children, uncorrected vision problems among school-aged children may have significant, long-term consequences if these problems negatively affect demand for education, school performance and ultimate schooling attainment.

Visual impairment may pose a significant constraint to children's development in China, particularly in rural areas. One study has shown that nearly half of all vision problems among children in the world occur in China (46%—Resnikoff et al., 2008). A large sample population-based study has also found that 24% of children with average age of 10 from western rural China had visual problems (Yi, Zhang, et al. 2015). It is estimated that the prevalence of myopia in rural China may exceed 60%, with two-thirds or more of rural children having no accurate correction (Congdon et al. 2008; Ma et al. 2014).

In this paper, we report the results of a randomized trial in poor regions of western China where free eyeglasses were distributed to myopic junior high school students. We examine the effects of this intervention on student performance on standardized exams in math, aspirations for further schooling and dropout behavior over the course of a school year. At baseline, 50.4% of the children needed eyeglasses, yet only 31% of the myopic children owned them. We find that offering free eyeglasses to students increases the average score of standardized exams by 0.14 standard deviations, raises aspirations to attend academic high school by 9 percentage points, and reduces dropout rate by 44% or 2 percentage points (from 4.8% to 2.7%).

These findings build on recent studies that evaluated the effects of providing eyeglasses to younger myopic students in primary schools on exam performance. Ma et al. (2014) find that the impact of providing free eyeglasses on the average scores of standardized exams is 0.11 standard deviations. Glewwe, Park and Zhao (2016) find that wearing eyeglasses for one school year increases the average scores of visually impaired students by 0.16 to 0.22 standard deviations, an improvement equivalent to 0.3 to 0.5 additional years of schooling.

Our results add to these previous studies by showing that free eyeglasses are effective in raising academic achievement among older children in junior high school and that they also affect outcomes related to ultimate schooling attainment that may not be captured by standardized exams alone. Although previous studies have shown effects of free eyeglasses on academic achievement among primary school aged students, the effects of providing free eyeglasses could differ among junior high students because a.) they have higher rates of poor vision on account of their age and because high stakes testing at the end of junior high also places an increased premium on school performance; b.) students themselves are more likely to choose whether to wear eyeglasses rather than the preferences of their parents or caregivers; and c.)

junior high students are more likely to be influenced by stigma and peers in their decision to wear eyeglasses. Previous studies show that the beliefs and attitudes of individuals about eyeglasses and their social environment, especially their parents, peers and teachers, may interfere with utilization of eyeglasses (Lynch and Cicchetti 1997; Hanushek, Kain and Markman 2003; Odedra et al. 2008).

Beyond improvement in exam performance, our results also show that addressing uncorrected vision problems—a key health constraint to learning in developing countries—can have substantial effects on a broader range of outcomes extending to school progression. Evidence of these downstream benefits strengthens the argument for subsidization or free provision of eyeglasses to disadvantaged students in developing countries. These results also suggest that, relative to students in primary schools, interventions targeting older children can also have meaningful effects and be highly cost-effective.

The remainder of the paper is organized as follows. Section II describes the research design, data collection and our statistical approach. In Section III, we report our findings, focusing on whether or not the availability of free eyeglasses has an impact on eyeglasses usage, academic performance, academic aspirations and school dropout rates. Section IV presents our conclusions.

II. Sampling, Randomization and Intervention, Data Collection, and Statistical Approach

2.1 Sampling

Our experiment took place in three nationally-designated poverty counties in Yulin prefecture, located in northern Shaanxi province.[3] To choose our sample of schools and students, we followed a three-step process. First, we constructed a sampling frame using a list of all rural junior high schools in the three counties. There were a total of 47 junior high schools on this list. Second, we randomly chose 32 junior high schools from this list. This sample size was determined based on power calculations which indicated that we required 16 schools per group.[4] One school left the study after the baseline survey, leaving 31 schools in the final sample. Third, within each school, the students from one class in each grade (grade seven and grade eight) were surveyed. In the 16 cases where there was more than one class in a grade, we randomly included one of these classes in impact evaluation.[5]

Sampled in this way, a total of 1974 grade seven and eight students were included in the final sample across the 31 schools. A description of the sample is shown in Table 1.

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[3] The net income of Shaanxi's rural residents was 9730 yuan ($1569) in 2014(Government of Yulin 2015), close to the average level of income for all of China (9892 yuan or $1569 in 2014—National Bureau of Statistics of the People's Republic of China[CNBS], 2015).

[4] We calculated that we needed 16 schools per experimental arm to detect a minimum effect size of 0.25 math score with 80% power at a 5% significance level. We assumed an adjusted intra-cluster correlation of 0.10 (the realized intra-cluster correlation is 0.049 when adjusted for students' characteristics and strata fixed effects), a pre- and post-intervention correlation of 0.5 and 15% loss to follow-up.

[5] Students in treatment schools (described below) who were not in classes selected for the sample still received free eyeglasses during the intervention period.

2.2 Randomization and Intervention

As part of the baseline survey (described fully below), all students were screened for myopia by a team of optometrists employed for the study. These optometrists were all trained by trainers from the Zhongshan Ophthalmic Center, Sun Yat-sen University (among the top ophthalmic centers in China) in order to ensure standardization and quality. Visual acuity (VA) was tested separately for each eye using tumbling E charts.[6] Students failed screening if they were determined to have an uncorrected VA less than or equal to 6/12 in either eye. Approximately one-half of students failed the vision screening (Table 1, row 3).

Following vision screening, students who failed were taken by bus to a clinic located in the central locations to undergo further vision testing. Only 2% of students who failed screening did not go. At the clinic, students underwent automated refraction (AR) by highly trained refractionists to determine the nature of their vision problem and whether vision could be improved with eyeglasses.[7] Prescriptions were then determined for the 96% of cases where vision could be improved with eyeglasses.

After refraction, eyeglasses were manufactured for all students (though the eyeglasses would not be given to the control students until after the endline—and this information was not made available to anyone). The eyeglasses were manufactured using high quality equipment which was brought from the US.

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[6] E charts are accepted as the standard for accurate visual acuity measurement (Camparini, Cassinari and Ferrigno 2001).

[7] The refractionists were from a nonprofit organization called Onesight, a foundation which aims at providing access to quality vision care and eyewear in underserved communities worldwide. The refractionists were all participating in a volunteer project that was working in the three sample counties.

After refraction and the baseline survey which took place at the same time (more details below), the schools were randomized into treatment and control groups. To improve power, we conducted the randomization within pairs of schools matched by county and by the number of students in the school found to require eyeglasses. Our analysis takes this randomization procedure into account by controlling for dummy variables for each matched pair (Bruhn and McKenzie 2009).

Following the randomization, free eyeglasses were distributed in treatment schools to the students found to require eyeglasses, regardless of whether they already had eyeglasses or not. Refractionists visited the schools and dispensed the eyeglasses, making adjustments to make sure the eyeglasses fit well and answered any questions students had about wearing and caring for their eyeglasses.

Students in control group schools were only provided with an eyeglass prescription and asked to take the prescription to their parents. It was not until after the endline survey was complete that the students in this group received free eyeglasses and students and teachers in control schools were unaware that they would be receiving free eyeglasses. Because students in this group did receive an eyeglass prescription (and information that they were myopic), we are therefore comparing a policy of providing free prescription eyeglasses to one of providing only eye screening and prescriptions.

2.3 Data Collection

The research group conducted baseline and endline surveys. The baseline survey was conducted in September 2013 (prior to the start of the intervention), which was at the beginning of 2013-14 academic year. The endline survey was conducted in May 2014, close to the end of the 2013-14 academic year.

In each round of the survey, the data collection effort consisted of two parts. First, our enumerators (graduate students from Shaanxi Normal University who were trained in enumeration techniques) administered questionnaires to students and teachers to collect information on student, family and school characteristics. In addition to basic student and household characteristics, student surveys also asked about eyeglass ownership and the use of eyeglasses. Use of eyeglasses is defined by whether a student wears his or her glasses and was measured with self-reported survey responses of whether children wore eyeglasses regularly in class. We also asked the student about their plans after junior high school or their *academic aspirations*. Specifically, we wanted to know if students intended a.) to attend academic high school; b.) to attend vocational high school; c.) to finish junior high school; or d.) go to work (or drop out) before the end of junior high.

In the second part of the survey, each student was given a standardized math exam. The questions used in the math exam were drawn from a bank of questions developed by the Trends in International Mathematics and Science Study (TIMSS) testing service. The TIMSS test is an international assessment of mathematics and science achievement of primary and junior high school students. To ensure coherence with the national curriculum, the test questions were chosen with assistance from educators in the local bureaus of education. We pretested the exam repeatedly to ensure its relevance and that the time limits were appropriate. The exam was timed carefully and proctored closely by two enumerators at each school. No feedback was given after the baseline test and no indication was given that we would administer another exam in the future. For the analysis part of our study, scores for the standardized math tests are normalized by the distribution of scores in each grade in the control group.

As part of the baseline survey, we administered the VA screening test referred to above. In order to calculate and compare different levels of VA in the empirical exercises in the rest of this paper, VA is measured by LogMAR, which are among the most commonly used continuous scales in the field of ophthalmology/optometry (Bailey and Lovie 1976; Grosvendor T 2007). The higher the LogMAR value is, the worse one's vision is.

Dropout was determined as part of the endline survey. For each student not in the classroom at the time of the endline survey (i.e., attritted), the survey team worked with homeroom teachers to determine if the student was merely absent or if they had a.) transferred to another school, b.) were out on leave, or c.) had dropped out of school. In the analysis dropout is a binary variable taking value of one if a student dropped out of school between the baseline and endline surveys and zero otherwise.

2.4 Summary Statistics and Baseline Balance

Of the 1974 students given eye examinations at baseline, 995 (50.4%) were found to need eyeglasses (Table 1, row 4, column 1). Such rates of poor vision, while high by international standards (Maul et al. 2000; Murthy et al. 2002), are similar to findings of previous studies among junior high students in China (He et al. 2007). Only these students are included in the analysis sample.

Table 2 shows descriptive statistics and tests of balance between the treatment and control groups for the analytical sample. This is the sample of students who failed the vision check, whose eyesight could be improved with eyeglasses, and who were included in the endline survey. An analogous table using the pre-attrition sample is Appendix Table 1.[8] At baseline, only 31% of the students who needed glasses owned them (Row 4). This rate of uncorrected myopia (69%) is similar to findings in the literature for younger children (Congdon et al. 2008; Yi, Zhang, et al. 2015). Overall, the two groups are balanced on observables at baseline. Among the 11 variables tested, there is only one with a significant difference between treatment and control, less than would be expected by chance. An omnibus test confirms that the differences between the two groups across all variables are jointly insignificant.[9] We do find that standardized math scores in the treatment group were higher than those in the control group at baseline (significant at the 10% level); we control for baseline exam scores in all subsequent analyses.

2.5 Statistical Approach

We estimate the treatment effects of providing free eyeglasses with ordinary least squares (OLS) regression. Only the students who were found to require

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8 During the survey, we identified 85 students as attritters (8.5%, 46 students in control group and 39 students in treatment group) that dropped out or transferred schools (for various reasons; most commonly they had moved to a nearby city with their parents).

9 Running a linear probability model: $Treatment_{ij}=\alpha_0+\alpha_1\times baselineic\_characteristic_{ij}+\varepsilon_{ij}$ gives a p-value of 0.29 for a test that coefficients on these interactions are jointly zero.

eyeglasses at baseline are included in the analysis sample. We estimate the following regression:

$$Y_{ij}=\alpha_0+\alpha_1 Treatment_j + X_i'\alpha_2 + \varphi_p'\alpha_3+\varepsilon_{ij} \qquad (1)$$

where Y_{ij} is the outcome variable at the endline survey for student *i* in school *j* among the students requiring eyeglasses. In the analysis below, Y_{ij} is one of several outcome variables: a.)the usage of eyeglasses; b.) standardized math scores (normalized by the distribution in the control group); c.) aspiration for further schooling; or d.) dropout. On the right hand side of equation (1). $Treatment_j$ is a dummy variable that is equal to one if the student is in a treatment school; X_i is a set of baseline controls; φ_p, is a vector of dummy variables for randomization strata (to account for the stratified randomization procedure); and ε_{ij} is an error term that is correlated within schools. The parameter α_1 gives the estimate of the causal effect of receiving free eyeglasses. Specifically, because the $Treatment_j$ variable is equal to one regardless of whether students received or wore eyeglasses they were given, α_1 gives the intention-to-treat (ITT) estimate of treatment effects, or the effects of distributing free eyeglasses regardless of takeup.

In the analysis that follows, we present results excluding and including an expanded set of baseline controls, X_i, including characteristics of students and schools at baseline: student gender, age, whether the student boards at school, ownership of eyeglasses at baseline, student VA measured in *LogMAR* (a continuous variable), standardized math score at baseline, whether both parents have migrated elsewhere for work, whether a parent attained more than 9 years of schooling, the teacher-student ratio of the school, and the total number of students in the school.

Motivated by the differences that exist between the students who did and did not own eyeglasses at baseline, we test the effects of free eyeglasses using the full sample as well as within subgroups of students with and without eyeglasses at baseline. In all of the regressions, we calculate robust standard errors to adjust for clustering by school.

III. Results

We examine the effects of providing free eyeglasses on three sets of outcomes. First, we test effects on the use of eyeglasses. Next, we test effects on outcomes intermediate to dropout behavior, including academic performance (as measured using standardized exams in Math) and aspirations for final schooling. Finally, we examine ultimate effects on dropout behavior during the school year.

3.1 Eyeglass Usage

Providing free eyeglasses increased the usage of eyeglasses as measured by the self-reported response of the students, although usage remained below 100%. According to regressions using Equation (1), providing free eyeglasses increased the self-reported usage of eyeglasses in class by 19 percentage points from a base of 50% in the control group at endline (significant at the 1% level; Table 3, row 1, column 1). When control variables are added, the estimate of program effect slightly increases to 19.4 percentage points and remains statistically significant (Table 3, row 1, column 2).

As might be expected, the effect of providing free eyeglasses differed by whether students owned glasses at baseline. Focusing on the students without eyeglasses at baseline (n=480), the usage of eyeglasses in class increased from 30% in control group to 56% in treatment group, an increase of 26 percentage points or 87% (significant at the 1% level; Table 3, row 1, columns 3 & 4). The program had no distinguishable impact on eyeglass usage for students with eyeglasses at baseline (Table 3, columns 5 & 6).

3.2 Intermediate Outcomes: Academic Performance and Aspirations

Table 4 shows estimated effects of the intervention on student standardized math exam scores (Panel A) and aspirations for further schooling measured using three specific dummy variables: a.) aspirations to attend academic high school (Panel B); b.) aspirations to attend vocational high school (Panel C); and c.) aspirations to attend any high school (Panel D). As with the previous table, we show effects for the full sample in columns 1 & 2, students without eyeglasses at baseline in columns 3 & 4, and students with eyeglasses at baseline in columns 5 & 6.

We find that providing free eyeglasses had a significantly positive effect on academic performance as measured by standardized math scores. In the full sample, we find that the intervention increase math exam scores by approximately 0.14 standard deviations (SD—Table 4, row 1, columns 1 & 2—significant at 10%). This effect on standardized math scores is comparable to that found for primary school students in previous studies (Glewwe, Park and Zhao 2016; Ma et al. 2014), and equivalent to approximately one-third of a year of schooling.

This effect on math scores in the full sample appears to come largely from increases in achievement among students without eyeglasses at baseline. Among the students without eyeglasses at baseline, we estimate that the provision of eyeglasses increased scores by 0.196 SD using the model including additional baseline controls (significant at the 5% level — Table 4, row 1, column 4).[10] Among the students with eyeglasses at baseline, we find no effect on math achievement (Table 4, row 1, column 6).

The effect of free eyeglasses on standardized math scores was accompanied by an increase in the aspirations of students to attend academic high school and an decrease in the aspirations of students to attend vocational high school. Specifically, after controlling for student baseline characteristics, providing free eyeglasses on average increased the probability that students said they planned to attend academic high school by 9 percentage points (significant at the 5% level—Row 3, column 2), while decreasing the probability of students planning to attend vocational high school by 10 percentage points (significant at the 5% level—Row 5, column 2). The magnitudes of the estimated effects are, in fact, quite large in percentage terms. According to the results, it means that the aspirations of students to attend academic high school increased by 25% (from 40% in control group) and aspirations to attend vocational high school decreased by 18% (from 56% in the control group).

Such a finding would suggest that providing eyeglasses shifted student aspiration from attending vocational high school (instead of not planning to attend any

[10] Without controlling for standardized math scores, the estimated effects in columns 1 to 4 in Panel A are also significant.

high school) to attending academic high school. In rural China today, vocational high schools are primarily operated to provide specific technical skills without emphasizing the teaching of basic educational skills, such as Chinese language, math, foreign language, and computer science (or skills that are in relatively higher demand in a modernizing economy—Liu et al. 2009). Thus, these patterns of changes in student aspiration for further schooling (as a result of eyeglasses provision) hint that students changed their plans in a way that might enhance their future human capital (i.e., if they were ultimately able to matriculate into academic high school).

3.3 Dropout

Table 5 reports estimated effects on dropout behavior. We find that providing free eyeglasses reduces dropout during the school year. Although the nine months of time that elapsed between the baseline and endline surveys is not a very long amount of time, there were still a large number of students dropping out of school during this period. Overall, approximately 5% of students dropped out over the course of the study in the control group. The rate of dropout also was higher among students in the control group without eyeglasses at baseline (6%) than students with eyeglasses at baseline (1%). In the full sample, we find that free eyeglasses reduced dropout by approximately 2 percentage points. In the specification that included control variables, the estimated effect on the dropout rate is 2.1 percentage points (Table 5, row 1, column 2; significant at the 10% level).[11] This represents a decrease of 44% (from 4.8%). Again, as in our results in the previous subsection, the estimated effect on

[11] The results were similar if a logit model was used (the marginal effect was 2.3 percentage points and also significant).

dropping out is concentrated among students without eyeglasses at baseline (Columns 3 & 4). For these students, the rate of dropout decreased by 48% from 6.2% in control group (Table 5, row 1, and column 4; significant at the 5% level). There is no significant effect for the students with eyeglasses at baseline (Table 5, row 1, column 6).

IV. Conclusion and Discussion

This paper reports results from a randomized trial testing the effects of providing free eyeglasses on academic outcomes of myopic junior high school students in a poor regions of western China. We find that the intervention has significant, positive effects on performance on standardized math exams, student aspirations for further schooling, and reduces dropout during the school year. Intention to treat estimates show that the provision of free eyeglasses increased performance on standardized math exams by 0.14 SD, increased student aspirations to attend academic high school by 9 percentage points, and reduced dropout by 44% during the school year. Program effects on standardized math exam scores and dropout were concentrated among students who did not own eyeglasses at baseline.

Even without considering potential benefits in terms of non-academic outcomes (effects on quality of life more generally, for example), the intervention is relatively cost-effective merely as an educational intervention. The cost of the intervention relative to the control group was approximately 376 yuan ($60) per child.[12] Focusing on the effects of the intervention on dropout behavior, these costs imply a cost-effectiveness ratio of 179 yuan ($28) per percentage point decrease in dropout over the course of the school year. It appears the cost-effectiveness of eyeglasses provision in this study compares favorably with other interventions focused on dropout of junior high students (Yi, Song, et al. 2015; Mo et al. 2013). Moreover, accounting for the gain in academic performance measured by standardized math scores, this study show that eyeglasses provision to junior high students seem to be more cost-effective relative to such intervention to primary students (269 yuan and 347 yuan per 0.1 standard deviations, respectively—Sylvia et al. ,2015)

Although our data do not allow us to fully examine the channels through which these effects occurred, we hypothesize that academic outcomes improved through three main mechanisms. First, providing eyeglasses increase the motivation of students to learn. One possible explanation for increased motivation is that myopic students found it difficult to keep up with instruction without being able to clearly read text books and follow work on a blackboard. Second, addressing the barrier to learning posed by uncorrected vision problems may have worked to crowd in other educational investments. Because the returns to other educational investments are increased when students are able to see clearly; students, parents and teachers may have invested more time and resources into learning. Finally, myopic students may

[12] We followed the methodologies discussed in Mcewan (2012) and Dhaliwal (2013). Costs of the program included the cost of eyeglasses (180,250 yuan or $28,611) and delivery of eyeglasses (13,760 yuan or $2,184),. The total programmatic cost of the program was thus 376 yuan ($60) per child. The cost of eye examinations are excluded since these were also administered in the control group. This calculation does not consider other social costs including student and teacher time and the cost of taxes.

have been made more confident that they could compete with their peers. This final mechanism could be important given China's competitive education system and that this competitive environment intensifies in junior high school (Loyalka et al. 2013).

The results we present come with two main caveats. First, our study took place in one poor region of western China and results may not apply to other settings. Second, we are only able to examine effects on dropout and other outcomes over the course of the school year. It is possible that the intervention merely delayed the decisions of students to leave school until after the end of the school year. If true, however, this would still constitute an increase in schooling attainment.

Despite these caveats, we believe this study clearly demonstrates the academic benefits of a program providing free eyeglasses to myopic junior high school students in China. These results add to previous studies in primary schools showing the effect of similar programs on student performance on standardized exams. In addition to showing effectiveness among older children, this study also shows that benefits extend to additional academic outcomes and imply that such a program may even have effects on ultimate schooling attainment. These additional results provide further justification for the subsidization of eyeglasses for myopic students in China and potentially other developing countries. Important questions for future research include how subsidization and distribution should take place (including alternative subsidization levels and methods of distribution), testing ways of encouraging the use of eyeglasses once distributed, examining effects on additional outcomes beyond academic outcomes as well as effects on longer term outcomes such as ultimate schooling attainment and earnings later in life.

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Table 1. Sample of Schools and Students

	Treatment group	Full Sample	By treatment	
			Control group	Treatment group
		(1)	(2)	(3)
(1)	Number of schools	31	16	15
(2)	Total number of students in baseline survey	1974	963	1011
(3)	Students failing eye screening (% of total)	1032 (52.3%)	496 (51.5%)	536 (53.0%)
(4)	Students requiring eyeglasses (% of total)	995 (50.4%)	480 (49.8%)	515 (50.9%)
(5)	Analytical sample: Students requiring eyeglasses and in follow-up survey (% of students in baseline requiring eyeglasses)	910 (91.5%)	434 (90.4%)	476 (92.4%)

NOTES. Data source: Authors' survey. A total of 1974 grade seven and eight students were included in our sample across the 31 schools. 1032 of the 1974 students failed eye screening and 995 students were found to require eyeglasses. 910 of the 995 students requiring eyeglasses were present for the second survey round.

Table 2. Descriptive Statistics and Balance Check on Post-Attrition Sample

		(1)	(2)	(3)	(4)
Baseline Characteristics:		Full Sample	Control Group	Treatment Group	Difference
		N=910	N=434	N=476	(3)-(2)
(1)	Male (0/1)	0.444	0.445	0.443	-0.001
		(0.497)	(0.498)	(0.497)	(0.036)
(2)	Age (years)	13.563	13.638	13.494	-0.145
		(1.137)	(1.191)	(1.083)	(0.115)
(3)	Boarding at school (0/1)	0.681	0.631	0.727	0.096
		(0.466)	(0.483)	(0.446)	(0.059)
(4)	Ownership of eyeglasses (0/1)	0.312	0.302	0.321	0.020
		(0.464)	(0.460)	(0.468)	(0.065)
(5)	Visual Acuity (LogMAR)	0.494	0.491	0.497	0.006
		(0.271)	(0.270)	(0.271)	(0.027)
(6)	At least one parent with education $\geqslant$ 9 years (0/1)	0.559	0.535	0.582	0.047
		(0.497)	(0.499)	(0.494)	(0.050)
(7)	Both parents migrant out (0/1)	0.090	0.104	0.078	-0.026
		(0.286)	(0.305)	(0.268)	(0.023)
(8)	Teacher-student ratio	0.118	0.119	0.116	-0.003
		(0.052)	(0.054)	(0.049)	(0.019)
(9)	Number of students in whole school	419.585	415.970	422.880	6.910
		(253.877)	(225.641)	(277.324)	(108.011)
(10)	Usage of eyeglasses at any time (0/1)	0.297	0.282	0.309	0.027
		(0.457)	(0.451)	(0.463)	(0.064)
(11)	Standardized math scores	0.182	0.043	0.310	0.267*
		(0.997)	(1.022)	(0.958)	(0.151)

NOTES. Data source: Baseline survey of authors' survey. Table uses post-attrition sample of students found to require eyeglasses at baseline. Column (1) shows mean and standard deviations (in parentheses) in the full sample; Column (2) shows statistics for the control group; Column (3) shows statistics for the treatment group. Column (4) shows the difference between the treatment and control groups and standard errors (in parentheses) that account for clustering at the school level. *, **, and *** indicate significance at 10%, 5% and 1%.

Table 3. Effect of Free Eyeglasses on Eyeglass Usage

Dependent variables:	Full Sample (of students requiring eyeglasses)		Students without eyeglasses at baseline		Students with eyeglasses at baseline	
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variables: Usage of eyeglasses in class (0/1)						
(1) Treatment	0.190***	0.194***	0.262***	0.261***	-0.023	-0.021
	(0.036)	(0.032)	(0.036)	(0.038)	(0.023)	(0.023)
(2) Mean in Control Group	0.501		0.304		0.954	
(3) Control for baseline characteristics	No	Yes	No	Yes	No	Yes

NOTES. Data source: Baseline and endline surveys by authors. Table uses sample of students found to require eyeglasses at baseline. Table shows the effects of free eyeglass treatment on usage of eyeglasses at endline. All regressions control for the value of the dependent variable, standardized math scores at baseline and randomization strata. Regressions in column (2), (4) and (6) additionally control for baseline characteristics (including students' gender, age, boarding status, visual acuity, standardized math scores, whether at least one parent with education ⩾ 9 years, whether both parents migrant out, teacher-student ratio and number of students in the school at baseline). Regressions in column (2) also additionally control for eyeglasses ownership at baseline. Standard errors accounting for clustering within schools shown in parentheses. Usage of eyeglasses at endline was measured using self-reported usage. Columns (1) and (2) show estimated effects in the full sample of students requiring eyeglasses; Columns (3) and (4) show estimated impacts among students without eyeglasses baseline; and Columns (5) and (6) show estimated impacts among students with eyeglasses at baseline *, **, and *** indicate significance at 10%, 5% and 1%.

Table 4. Effect of Free Eyeglasses on Students' Performance and Academic Aspirations

Dependent variables:	Full Sample (of students requiring eyeglasses)		Students without eyeglasses at baseline		Students with eyeglasses at baseline	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Standardized math scores						
(1) Treatment	0.141*	0.142*	0.159*	0.196**	0.040	0.063
	(0.079)	(0.074)	(0.089)	(0.083)	(0.077)	(0.069)
(2) Mean in Control Group	0.071		0.092		0.022	
Panel B: Aspiration to academic high school (0/1)						
(3) Treatment	0.090*	0.090**	0.092*	0.075	0.071	0.106
	(0.044)	(0.040)	(0.046)	(0.048)	(0.075)	(0.072)
(4) Mean in Control Group	0.396		0.363		0.473	
Panel C: Aspiration to vocational high school (0/1)						
(5) Treatment	-0.099**	-0.101**	-0.103**	-0.096*	-0.085	-0.103*
	(0.044)	(0.043)	(0.050)	(0.052)	(0.058)	(0.056)
(6) Mean in Control Group	0.560		0.591		0.489	
Panel D: Aspiration to any high school (0/1)						
(7) Treatment	-0.010	-0.011	-0.011	-0.021	-0.014	0.003
	(0.014)	(0.012)	(0.016)	(0.014)	(0.029)	(0.029)
(8) Mean in Control Group	0.956		0.954		0.962	
(9) Control for baseline characteristics	No	Yes	No	Yes	No	Yes

NOTES. Data source: Baseline and endline surveys by authors. Table uses sample of students found to require eyeglasses at baseline. Table shows the effect of free eyeglass treatment on students' academic performance, aspiration to academic high school, aspiration to vocational high school and aspiration to any high school. All regressions control for standardized math scores at baseline and randomization strata. Regressions in column (2), (4) and (6) additionally control for baseline characteristics (including students' gender, age, boarding status, visual acuity, standardized math scores, whether at least one parent with education ⩾ 9 years, whether both parents migrant out, teacher-student ratio and number of students in the school at baseline). Regressions in column (2) also additionally control for eyeglasses ownership at baseline. Standard errors accounting for clustering within schools shown in parentheses. Standardized math scores measured by TIMSS test. Aspiration to academic high school is 1 if the students plan to attend a regular high school after graduation and is 0 if not. Aspiration to vocational high school is 1 if the students plan to attend vocational high school after graduation and is 0 if not. Aspiration to any high school is 1 if the students plan to attend any type of high school after graduation and is 0 if not. Columns (1) and (2) show estimated effects in the full sample of students requiring eyeglasses; Columns (3) and (4) show estimated impacts among students without eyeglasses baseline; and Columns (5) and (6) show estimated impacts among students with eyeglasses at baseline *, **, and *** indicate significance at 10%, 5% and 1%.

Table 5. Effect of Free Eyeglasses on Dropout Behavior

Panel	Full Sample (of students requiring eyeglasses)		Students without eyeglasses at baseline		Students with eyeglasses at baseline	
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variables: Dropout (0/1)						
(1) Treatment	-0.023**	-0.021*	-0.030**	-0.030**	0.006	-0.001
	(0.010)	(0.010)	(0.014)	(0.014)	(0.011)	(0.009)
(2) Mean in Control Group	0.048		0.062		0.014	
(3) Control for baseline characteristics	No	Yes	No	Yes	No	Yes

NOTES. Data source: Baseline and endline surveys by authors. Table uses sample of students found to require eyeglasses at baseline. Table shows the effect of free eyeglass treatment on students' dropout behavior at endline. All regressions control for the standardized math scores at baseline and randomization strata. Regressions in column (2), (4) and (6) additionally control for baseline characteristics (including students' gender, age, boarding status, visual acuity, standardized math scores, whether at least one parent with education ⩾ 9 years, whether both parents migrant out, teacher-student ratio and number of students in the school at baseline). Regressions in column (2) also additionally control for eyeglasses ownership at baseline. Standard errors accounting for clustering within schools shown in parentheses. Dropout is 1 if the students drop out of school during the baseline survey to the endline survey and is 0 if not. Columns (1) and (2) show estimated effects in the full sample of students requiring eyeglasses; Columns (3) and (4) show estimated impacts among students without eyeglasses baseline; and Columns (5) and (6) show estimated impacts among students with eyeglasses at baseline *, **, and *** indicate significance at 10%, 5% and 1%.

Appendix Table 1. Descriptive Statistics and Balance Check on Pre-Attrition Sample

		(1)	(2)	(3)	(4)
Baseline Characteristics:		Full Sample	Control Group	Treatment Group	Difference
		N=995	N=480	N=515	(3)-(2)
(1)	Male (0/1)	0.453	0.463	0.445	-0.018
		(0.498)	(0.499)	(0.497)	(0.036)
(2)	Age (years)	13.616	13.704	13.534	-0.170
		(1.160)	(1.198)	(1.118)	(0.115)
(3)	Boarding at school (0/1)	0.684	0.640	0.726	0.087
		(0.465)	(0.481)	(0.446)	(0.057)
(4)	Ownership of eyeglasses (0/1)	0.303	0.290	0.315	0.025
		(0.460)	(0.454)	(0.465)	(0.061)
(5)	Visual Acuity (LogMAR)	0.494	0.495	0.493	-0.001
		(0.272)	(0.272)	(0.272)	(0.026)
(6)	At least one parent with education ⩾ 9 years (0/1)	0.274	0.279	0.270	0.043
		(0.446)	(0.449)	(0.444)	(0.053)
(7)	Both parents migrant out (0/1)	0.092	0.104	0.082	-0.023
		(0.290)	(0.306)	(0.274)	(0.023)
(8)	Teacher-student ratio	0.118	0.119	0.118	-0.001
		(0.052)	(0.054)	(0.050)	(0.019)
(9)	Number of students in whole school	413.120	414.538	411.798	-2.739
		(250.194)	(225.609)	(271.322)	(105.122)
(10)	Usage of eyeglasses in class (0/1)	0.286	0.270	0.302	0.032
		(0.452)	(0.444)	(0.459)	(0.061)
(11)	Standardized math scores	0.151	0.007	0.284	0.277*
		(1.010)	(1.025)	(0.977)	(0.148)

NOTES. Data source: Baseline and endline surveys by authors. Table uses sample of students found to require eyeglasses at baseline. Column (1) shows mean and standard deviations (in parentheses) in the full sample; Column (2) shows statistics for the control group; Column (3) shows statistics for the treatment group. Column (4) shows the difference between the treatment and control groups and standard errors (in parentheses) that account for clustering at the school level. *, **, and *** indicate significance at 10%, 5% and 1%.